FINAL REPORT

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OPTICAL AND STRUCTURAL STUDIES OF OPTICAL MATERIALS

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INTRODUCTION

The research project, in general, involved the preparation and study of various materials that have a potential interest for their optical properties. The materials studied have included several refractory carbide, transition metal alloys, high temperature superconducting systems, and a few other materials. The carbides were studied to evaluate their vacuum ultraviolet and soft X-ray reflectance properties for application as mirror materials. Some materials were characterized by ellipsometry measurements, using a helium-neon laser. Some high temperature superconductor systems, glasses, and other materials have been studied by Raman spectroscopy using an argon-ion laser.

SAMPLE PREPARATIONS

Sample preparations have been an important part of the research work. Facilities have been set-up for the preparation of bulk and thin film materials. Four different types of furnances are available for the preparation of bulk materials and alloys. Currently various high temperature superconducting systems are being prepared. There is a magnetron sputtering system with an R. F. power supply for preparing thin film materials. Some commercially obtained metal targets are available. Work has included the preparation of two inch diameter oxide sputtering targets. In collaboration with the Electrical Engineering Department at Howard University carbide materials have been prepared by the chemical vapor deposition

(C.V.D.) technique.

MATERIALS

The research program has been concerned with the study of several different kinds of materials. The measurement and study of some of the optical properties such as reflectivity and optical constants is dependant of having samples with good reflective surfaces. The SiC samples prepared in Howard's Electrical Engineering Department have excellent reflectivity results. We have studied various kinds of TaC samples. These have included commerically obtained hot pressed TaC, bulk single crystal TaC, and C.V.D. TaC.

The program has included the study of magnetic alloys such as CuNi and FeAu alloy systems. Various high temperature systems such as Y-Ba-Cu-O and Bi-Si-Ca-Cu-O have been prepared and studied.

RESEARCH PROGRAMS

I. Preparation and study of materials for mirror candidates in the vacuum ultraviolet spectral regions work has concentrated on tantalum carbide and silicon carbide materials. The reflectance of the samples were compared with values obtained with the GSFC superpolished silicon carbide mirror. The silicon carbide samples prepared at Howard gave very good reflectivity results, close to the superpolished material. The tantalum carbide samples did not give high reflectivity results. A variety of other physical measurements were made on the tantalum carbide samples, in order to characterize the material and attempt to understand the low reflectivity results. These other measurements have included ellipsometer measurements, a. c. magnetic susceptibility measurements, and X-ray diffraction studies. Tantalum carbide can form compounds with varying amounts of carbon vacancies. Its physical properties can vary greatly with its stoichiometry.

2. Some work has been devoted to preparing a cryostat for the determiniation of optical and ellipsometry properties of optical materials as a function of temperature. A standard Infrared Laboratories, model HD-I dewar has been obtained. The dewar can be used with liquid nitrogen or liquid helium. Some modifications have been made on the dewar.

3. During the past year work has concentrated on X-ray diffraction studies on various materials. The different TaC samples have been studied. X-ray diffraction measurements have been made as function of temperature down to 80oK. The change in the lattice constants with temperature are being studied. The various high temperature super-conducting samples that we have prepared are being characterized by X-ray diffraction studies. The presence of known super-conducting crystal structures are easily identified.